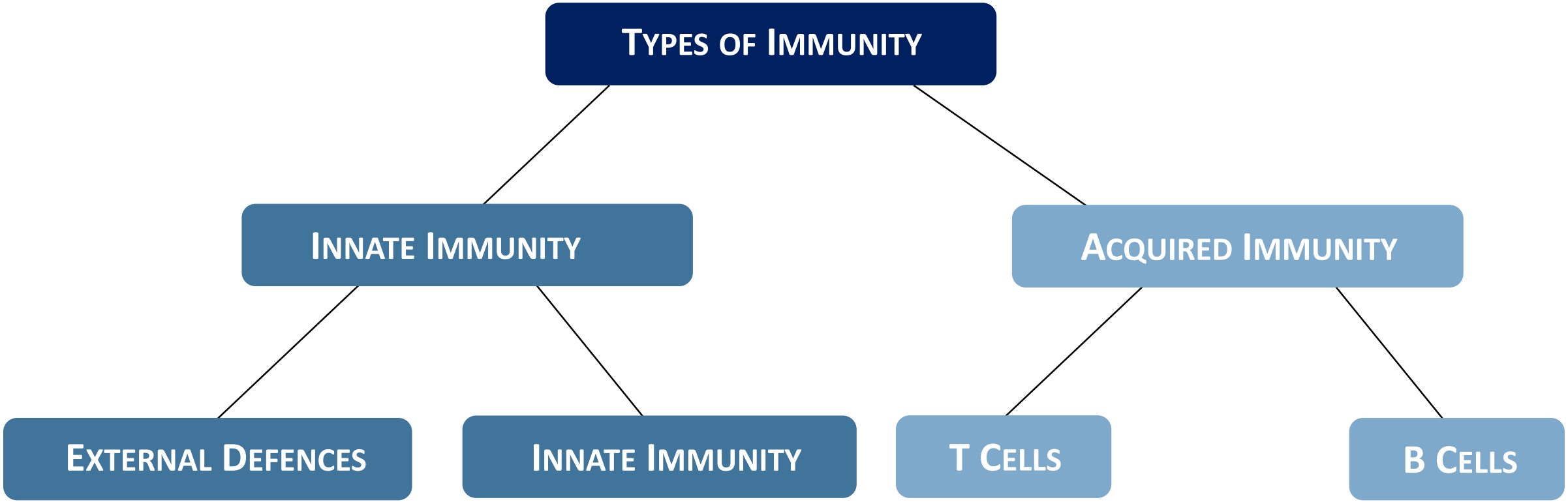
Immune System AP

SBI4UP

MS. FRANKLIN



- Skin
- Mucus layer

- Phagocytic Cells
- Antimicrobial proteins
- Inflammatory Response
- Natural Killer Cells

Innate Immunity

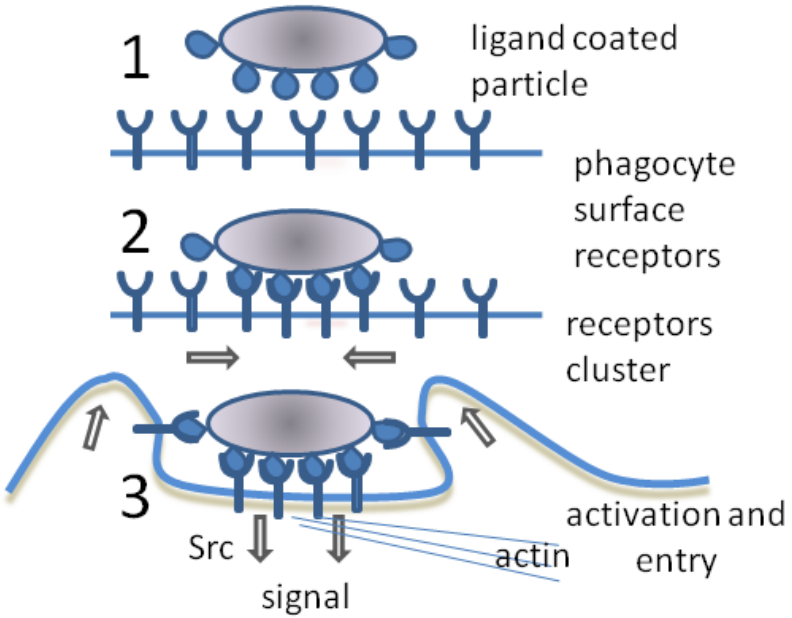
External Defences: the pathogen must first enter through the external barriers in order to penetrate the host. This is the first line of defense exhibited by organisms

1) *Intact skin:* if there is a tiny abrasion the pathogen may enter the body

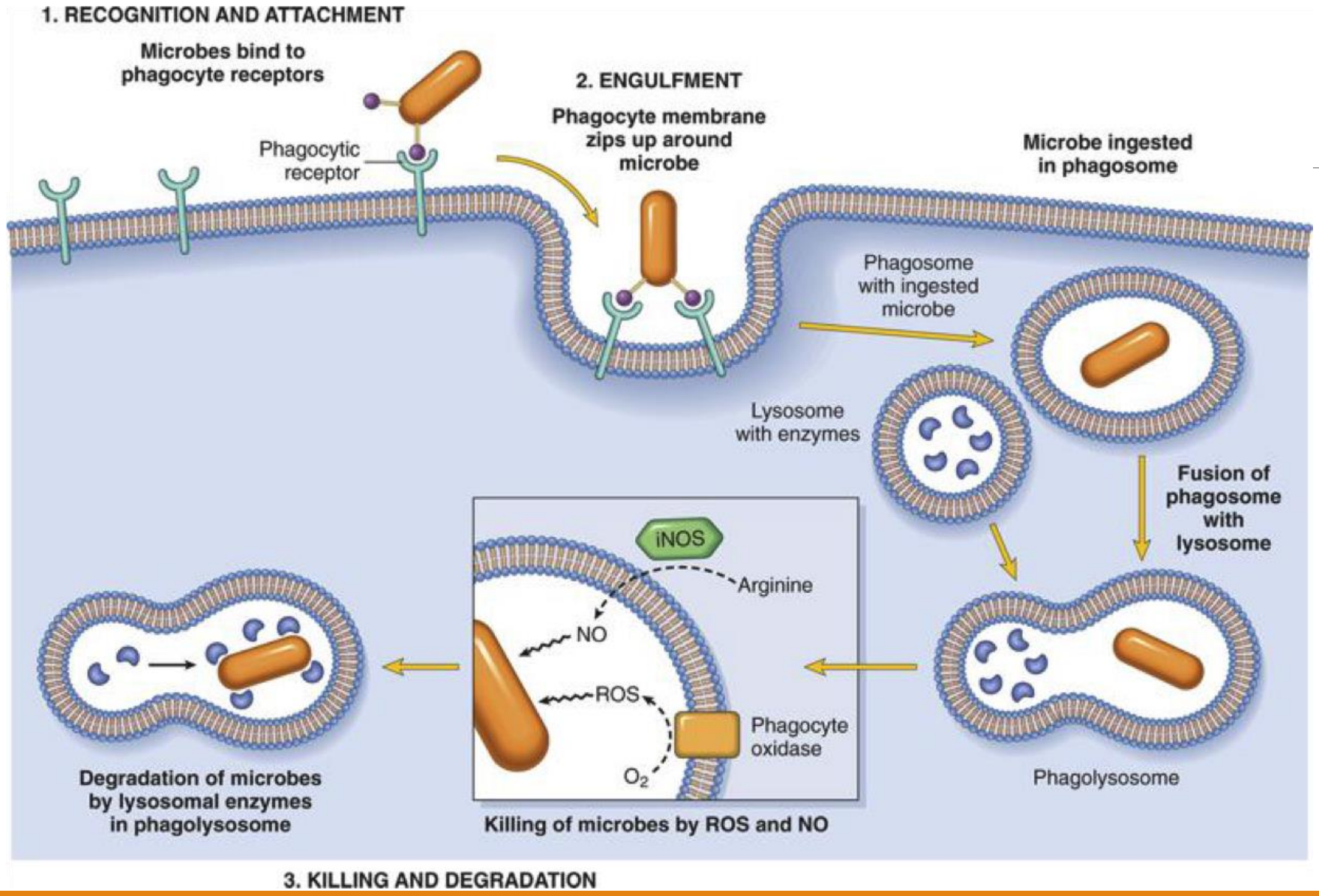
2) *Mucus Lining:* secreted by the epithelial cells of the respiratory and digestive tract.

Innate Immunity

Internal Cellular and Chemical Defenses: If the pathogen manages to enter the human body, it must now fight against internal defense mechanisms. Most of these defenses involve ***'phagocytosis'***



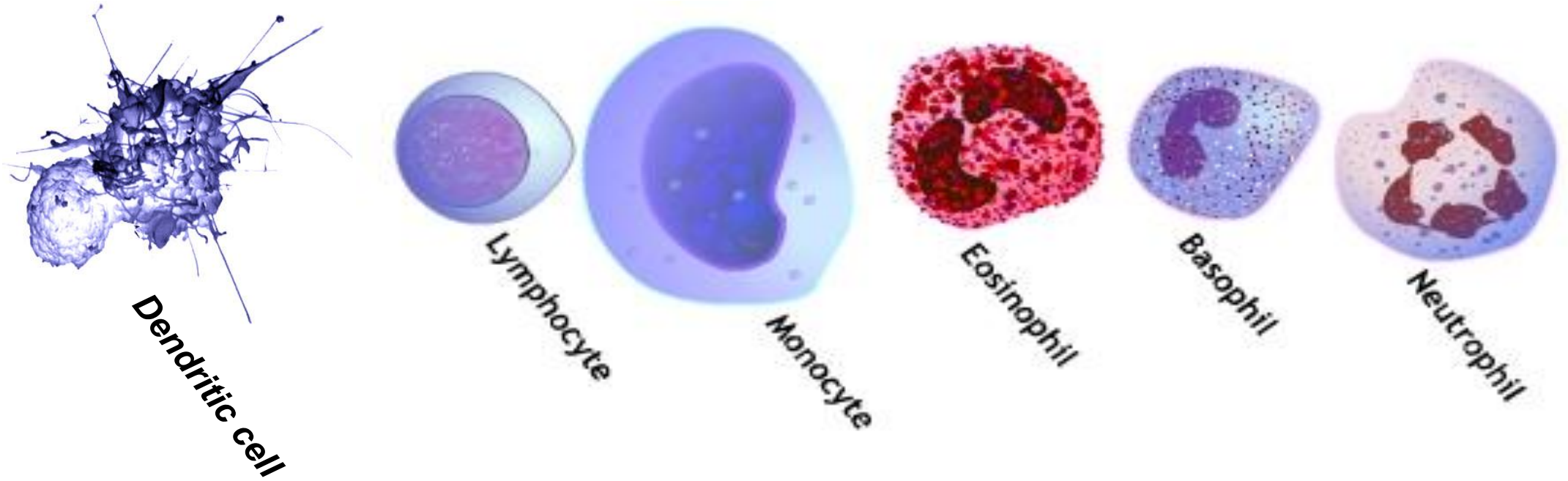
Phagocytic cells will attach to the prey through receptors and engulf the pathogen.

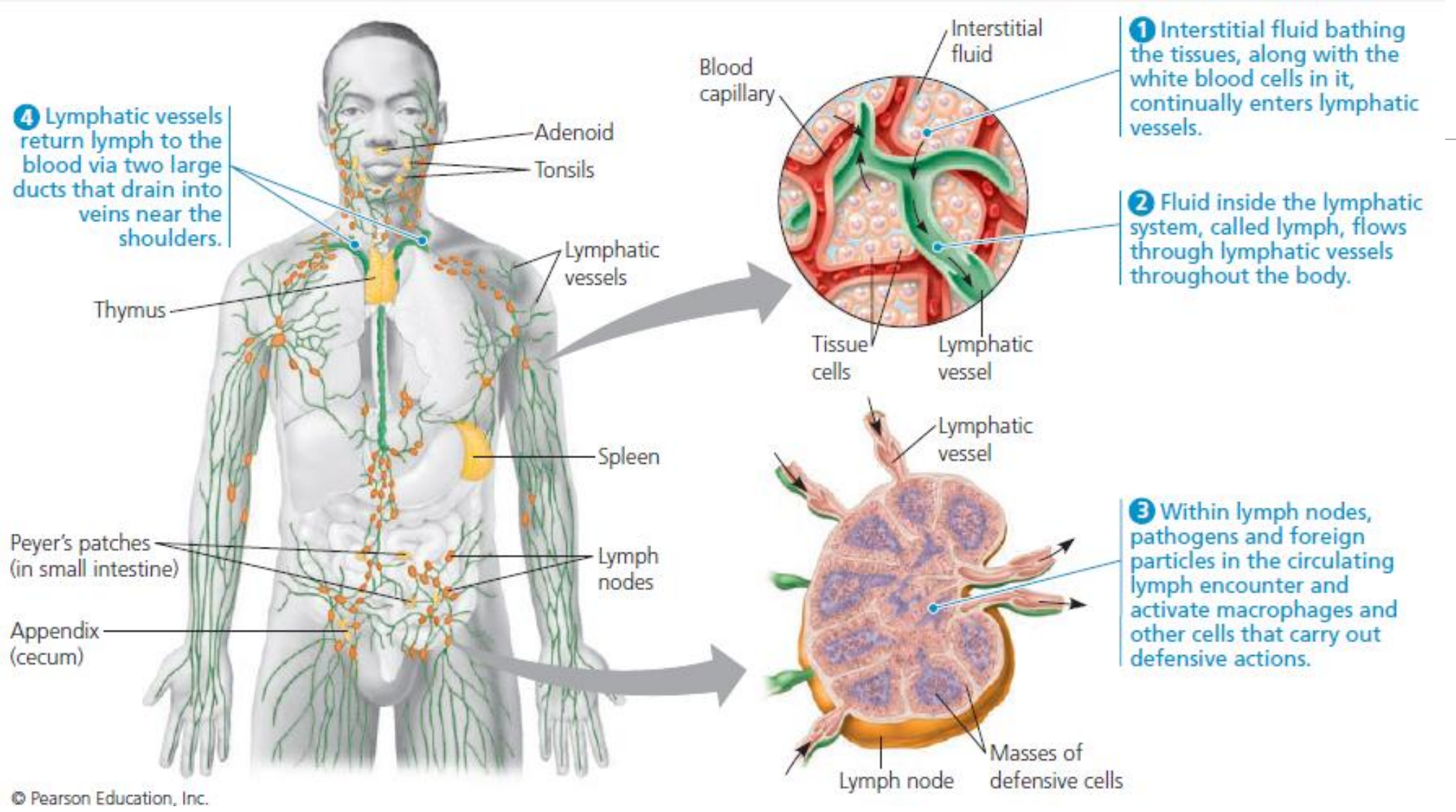


Some viruses and bacteria have developed mechanisms that have enabled them to either not be recognized by the receptors or be resistant against the enzymes in the lysosomes.

Internal Defenses

1) There are four main types of ***white blood cells*** (a.k.a leukocytes). Each will differ in its life span and phagocytic ability.




4 Lymphatic vessels return lymph to the blood via two large ducts that drain into veins near the shoulders.
Adenoid
Tonsils
Lymphatic vessels
Thymus
Spleen
Peyer's patches (in small intestine)
Lymph nodes
Appendix (cecum)
Blood capillary
Interstitial fluid
1 Interstitial fluid bathing the tissues, along with the white blood cells in it, continually enters lymphatic vessels.
2 Fluid inside the lymphatic system, called lymph, flows through lymphatic vessels throughout the body.
Tissue cells
Lymphatic vessel
Lymphatic vessel
3 Within lymph nodes, pathogens and foreign particles in the circulating lymph encounter and activate macrophages and other cells that carry out defensive actions.
Lymph node
Masses of defensive cells
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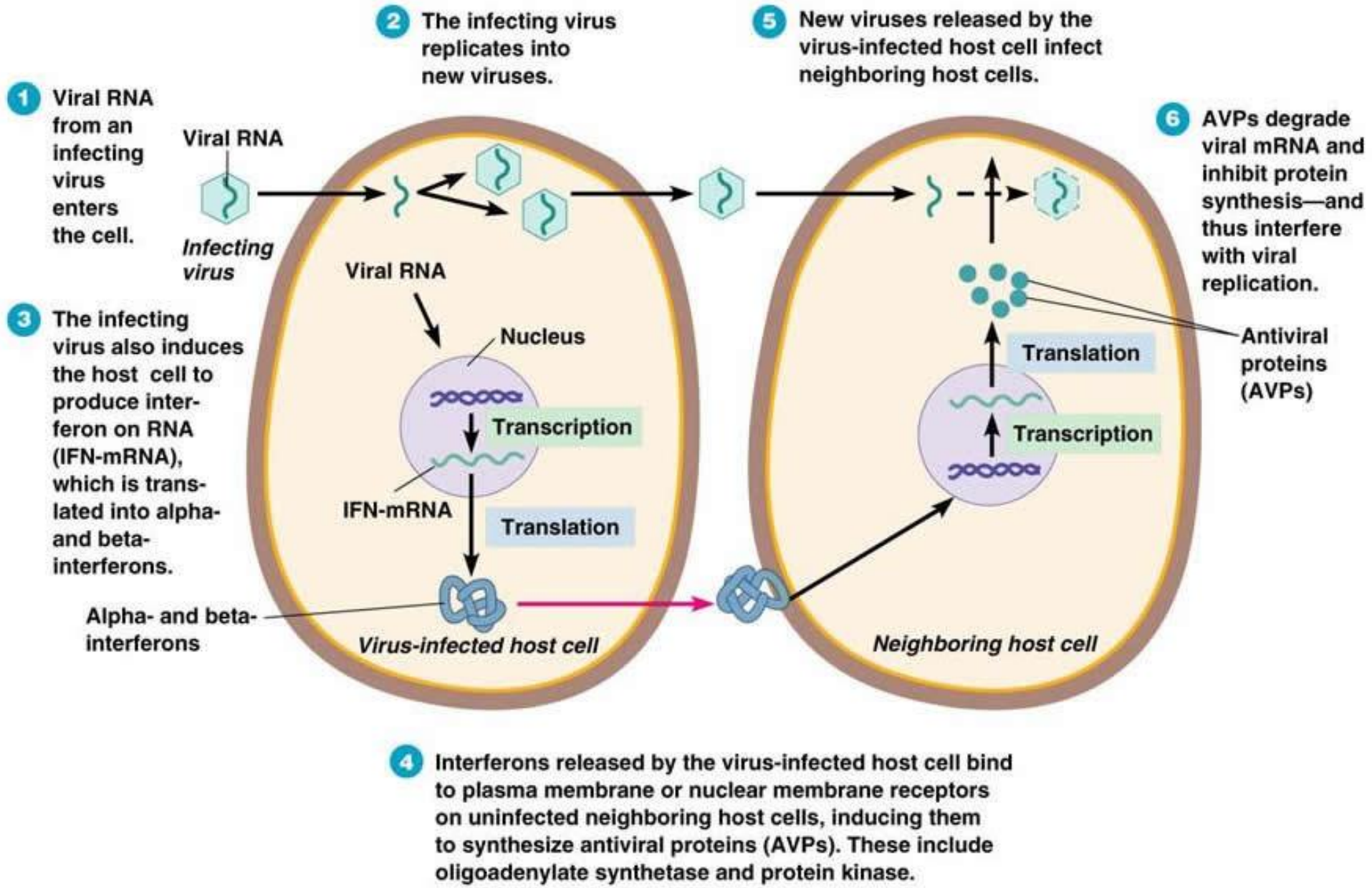
Internal Defences

2) Antimicrobial Proteins:

Belong to the ***complement system***. Proteins are only activated in the presence of a pathogen.

Interferon α and β:

Interferon γ:


1 Viral RNA from an infecting virus enters the cell.
Viral RNA
Infecting virus
2 The infecting virus replicates into new viruses.
Viral RNA
3 The infecting virus also induces the host cell to produce interferon on RNA (IFN-mRNA), which is translated into alpha- and beta-interferons.
Nucleus
Transcription
IFN-mRNA
Translation
Alpha- and beta-interferons
Virus-infected host cell
4 Interferons released by the virus-infected host cell bind to plasma membrane or nuclear membrane receptors on uninfected neighboring host cells, inducing them to synthesize antiviral proteins (AVPs). These include oligoadenylate synthetase and protein kinase.
5 New viruses released by the virus-infected host cell infect neighboring host cells.
6 AVPs degrade viral mRNA and inhibit protein synthesis—and thus interfere with viral replication.
Translation
Transcription
Antiviral proteins (AVPs)
Neighboring host cell

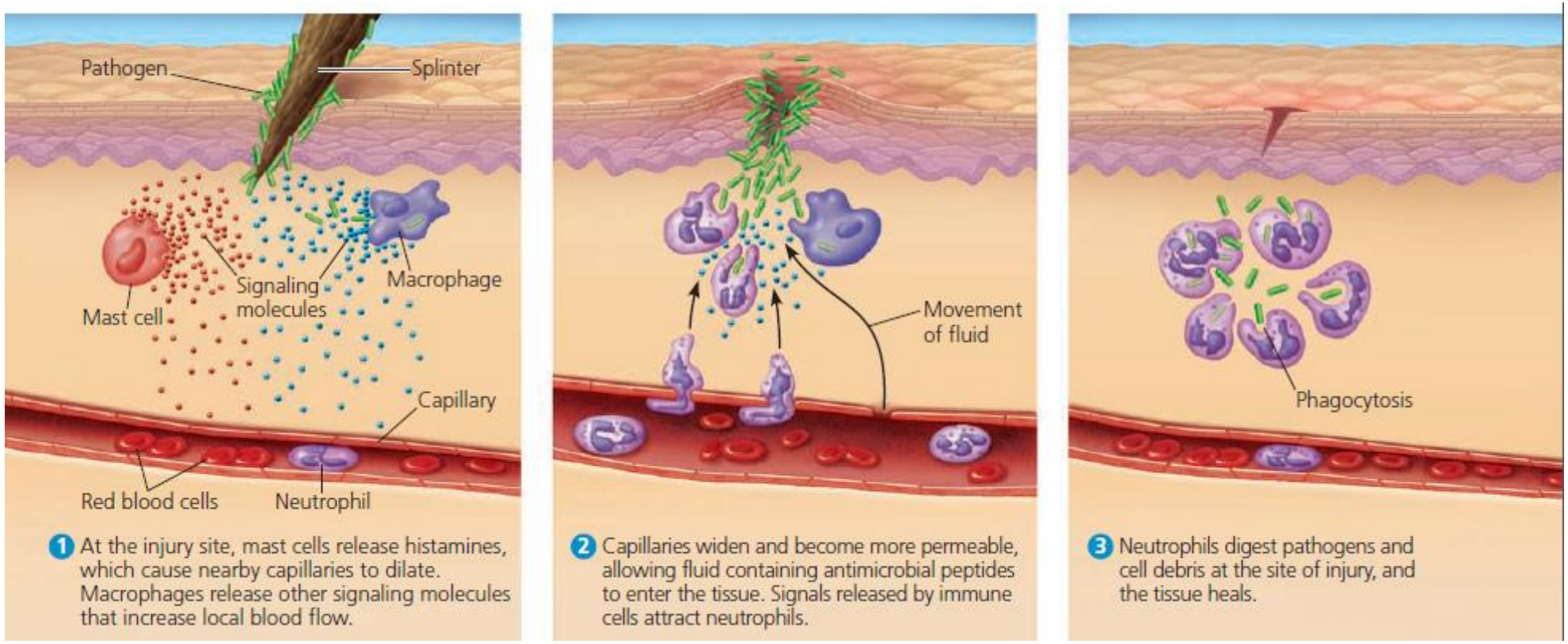
Internal Defences

3) Inflammatory Response: Chemicals are released by cells to initiate an inflammatory response when tissues are damaged.

- ***Mast cells*** located in tissues will release ***histamine***. Other chemicals released by the mast cells and macrophages will help dilate the blood vessels and increase blood flow.

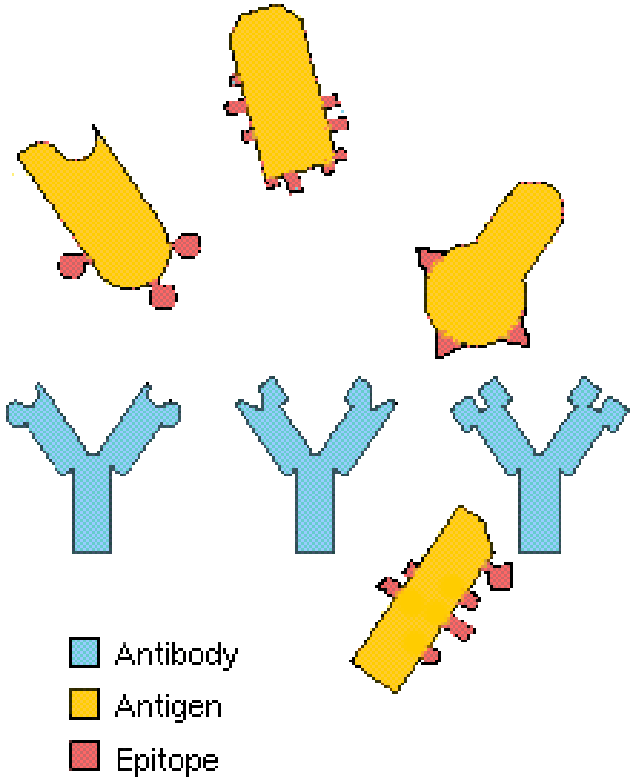
- This mechanism is essential to ensuring that the appropriate proteins and cells go to the site of infection.

Internal Defenses: Inflammatory Response



Acquired Immunity

Lymphocytes are the primary white blood cells involved in the secondary response. They are activated by other phagocytic cells through the release of cytokines.



Lymphocytes release antibodies that recognize the epitope of the antigen. Antigens are proteins that are either on the surface of the pathogen or the toxins released by the pathogen.

Both lymphocytes contain approximately 100 000 antigen receptors on their cell membrane that recognize the antigens.

Lymphocytes

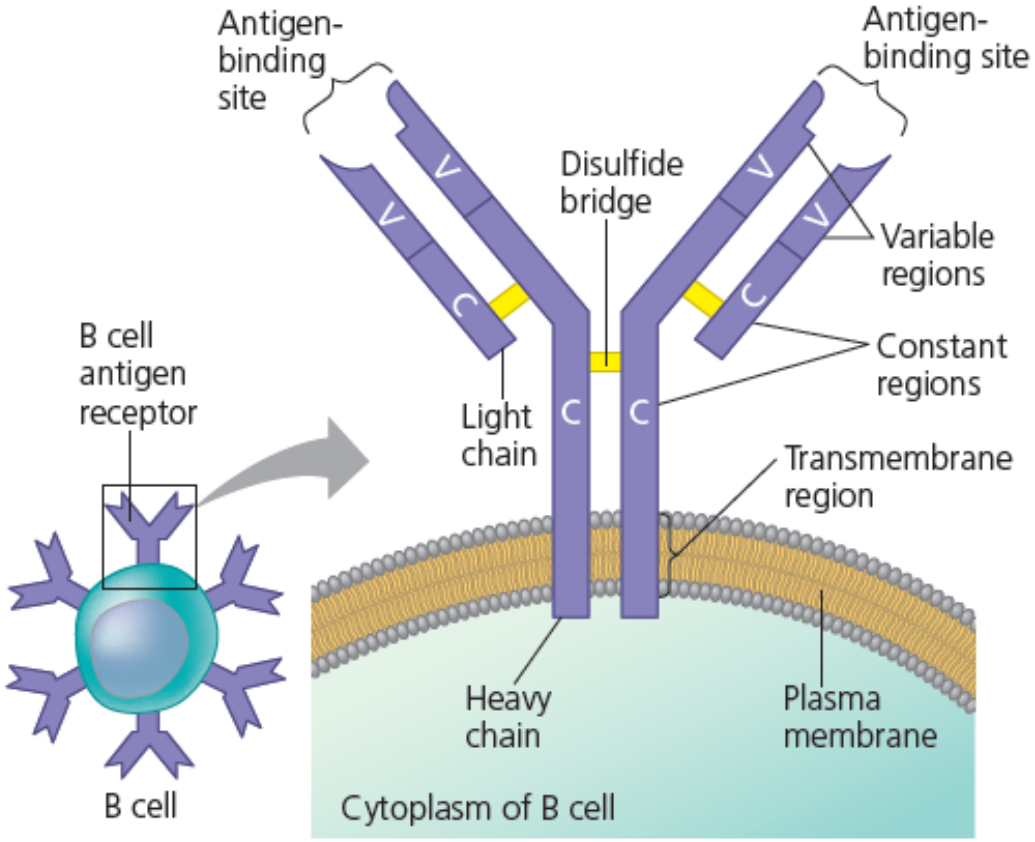
There are two main type of lymphocytes:

1) B lymphocytes (B cells):

2) T lymphocytes (T cells):

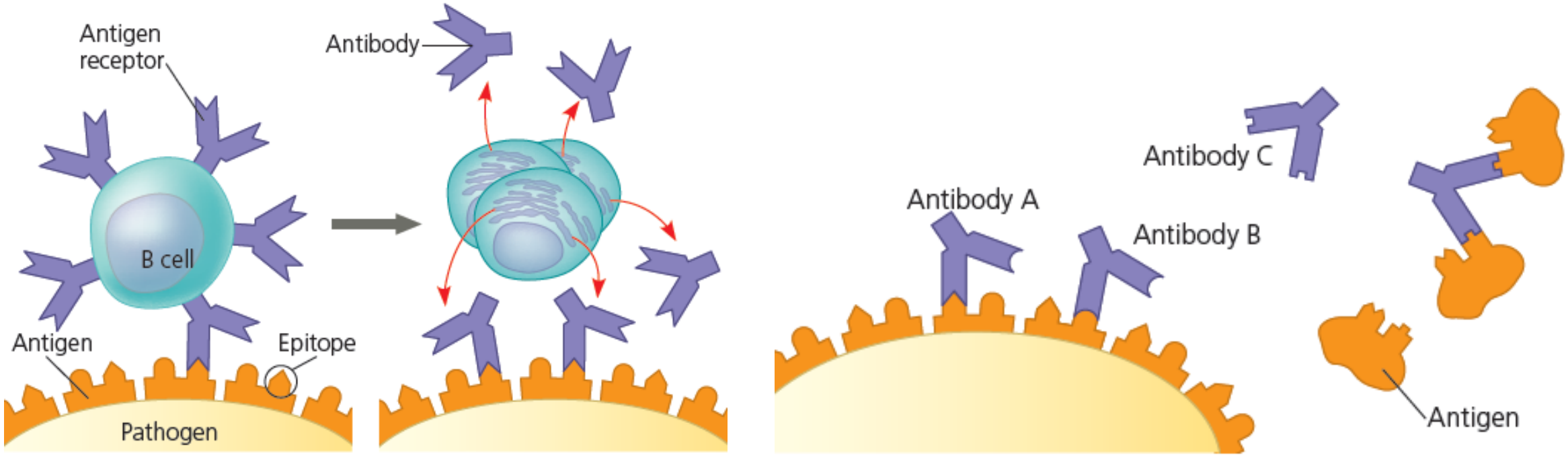
B Cells

Each B cell will have two identical antigen-binding sites. When the antigen binds it is held by non covalent bonds to the V-region of the receptor.



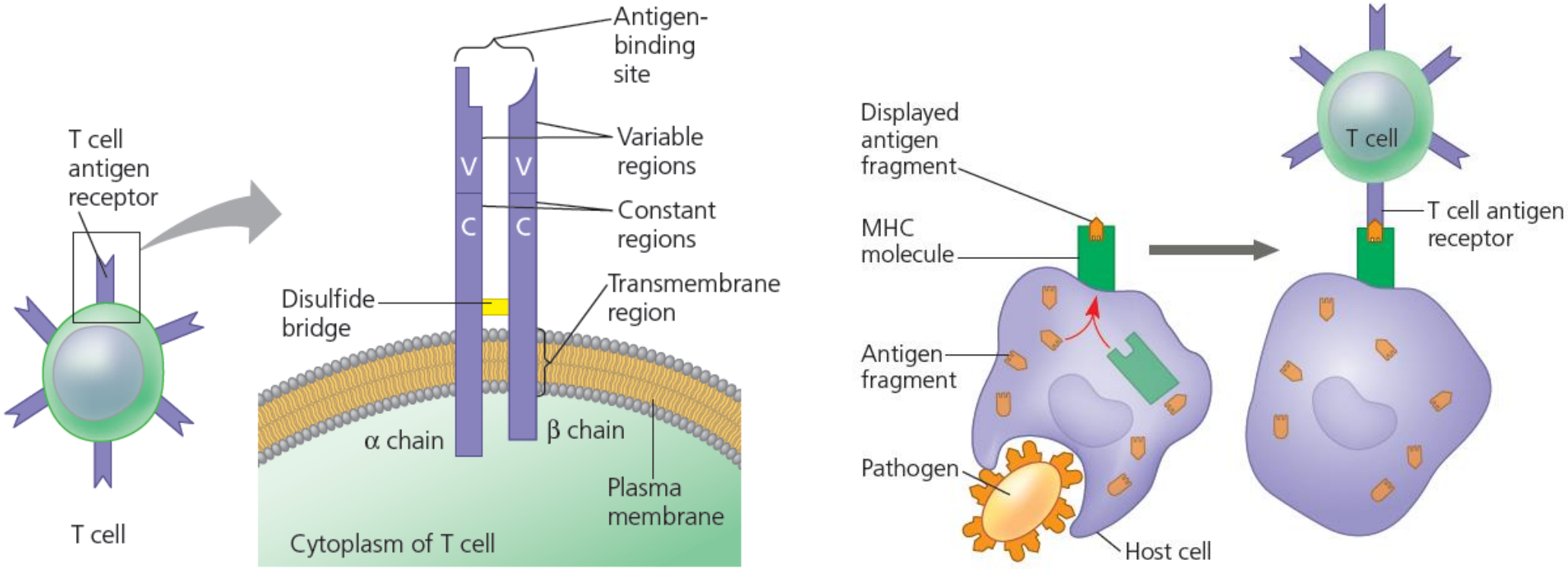
The variable regions will vary in amino acid sequence between different B-cells so that it is able to recognize a wide variety of pathogens.

B Cells

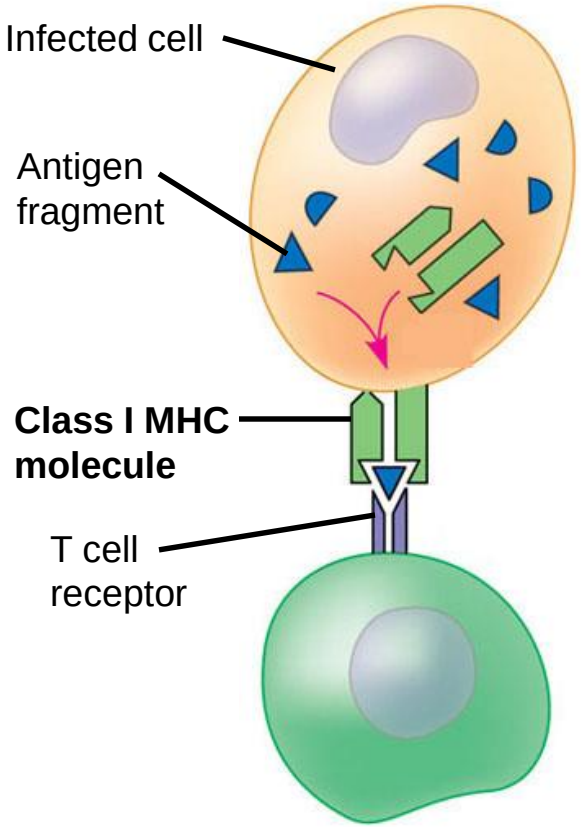

Antigen receptor
B cell
Antigen
Epitope
Pathogen
Antibody
Antibody A
Antibody B
Antibody C
Antigen

T Cells

The T-cells are able to recognize fragments of antigens that are presented on ***MHC molecules (major histocompatibility complex)*** . The infected cells present fragments of the pathogen on the cell surface.



T Cells



(a) Cytotoxic T cell

1 A fragment of foreign protein (antigen) inside the cell associates with an MHC molecule and is transported to the cell surface.

2 The combination of MHC molecule and antigen is recognized by a T cell, alerting it to the infection.

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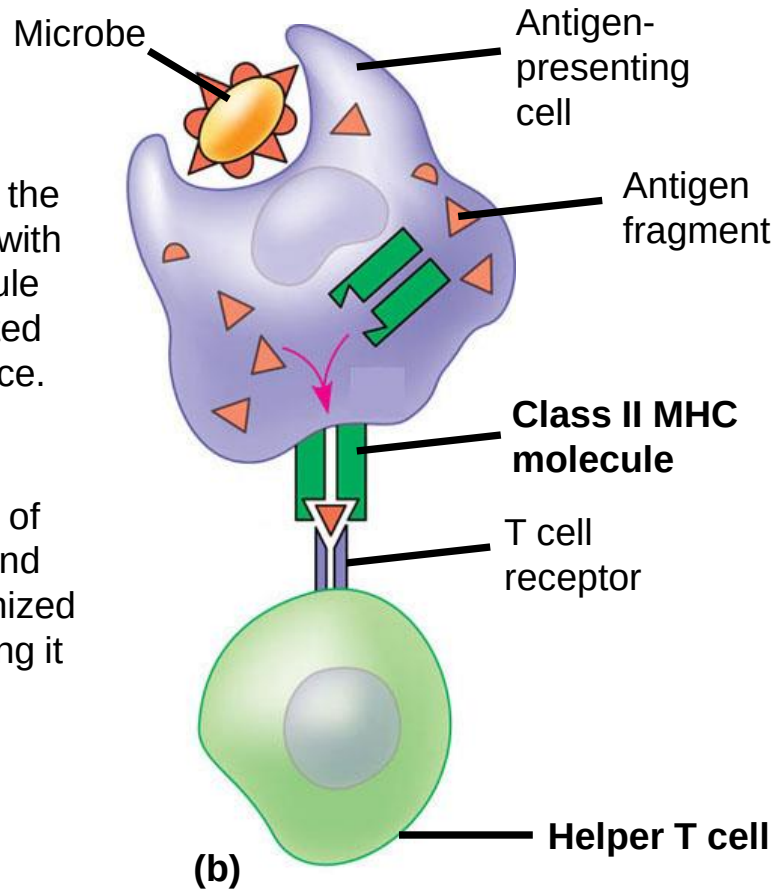


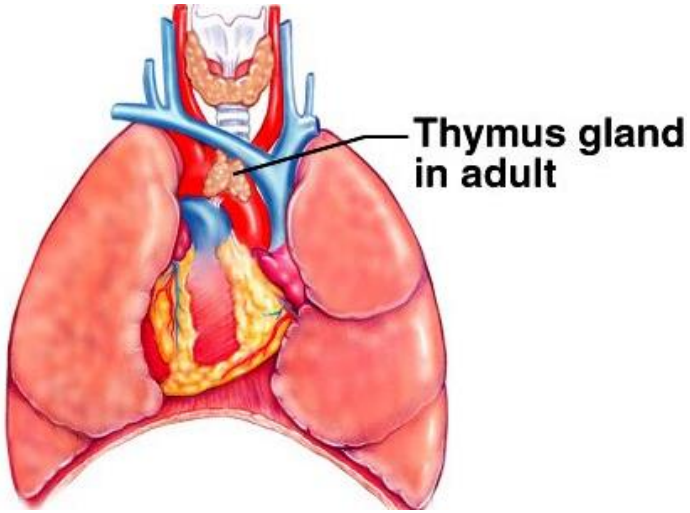
(b)

Lymphocyte Development

Lymphocytes are made by stem cells in the bone marrow. Some are delivered to the ***thymus*** will develop into a ***T cell***. Lymphocytes that remain in the ***bone marrow*** develop into a ***B cell***.

The development of ***lymphocytes*** happen in three main steps:

1) Lymphocyte diversity
2) Removal of self-reactive lymphocytes
3) Clonal Selection of Lymphocytes

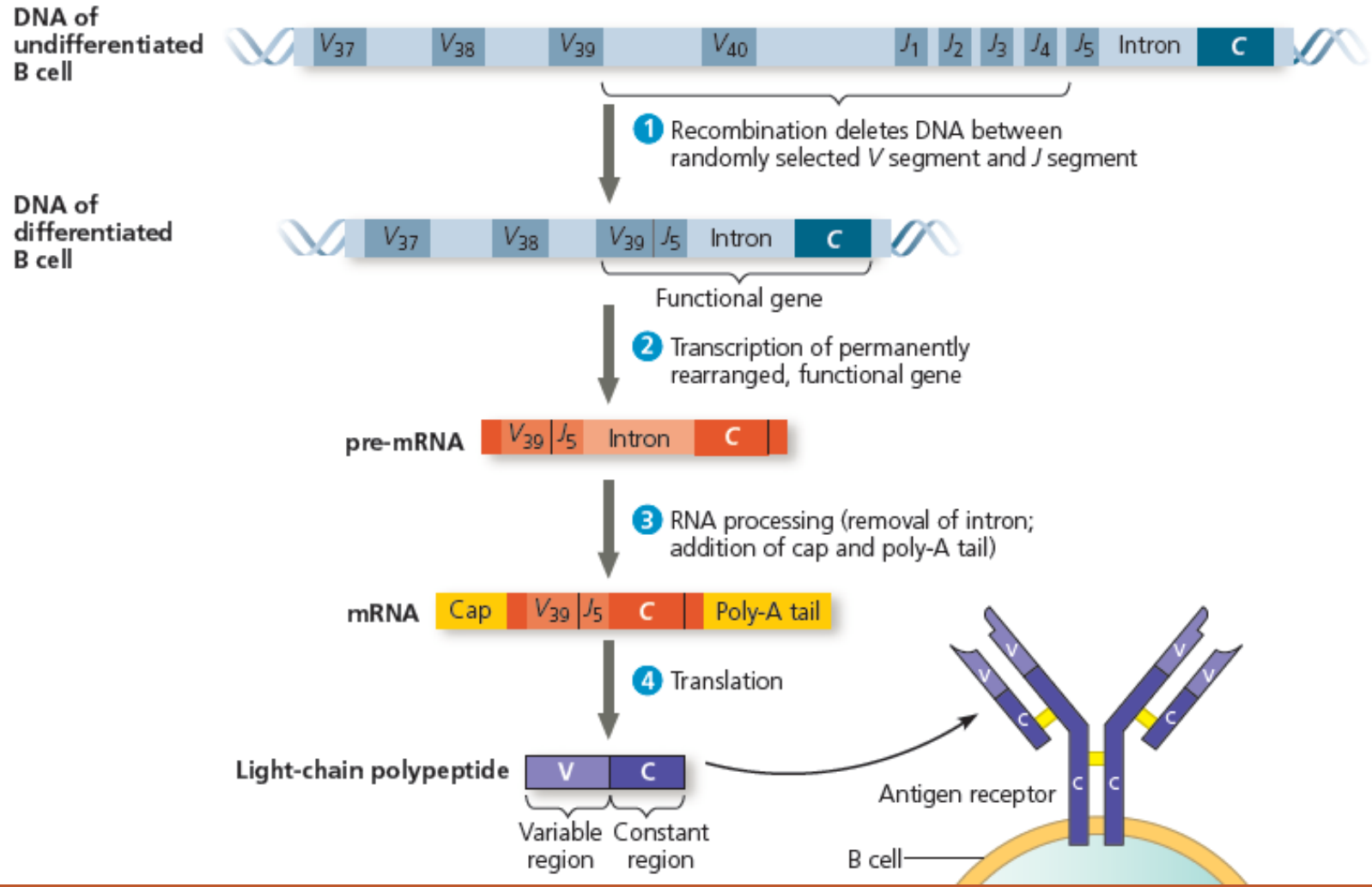


1) **LYMPH. DIVERSITY**
2) Removal of Self-reactive Lymph.
3) Clonal Selection of Lymph.

1) Lymphocyte Diversity

The variable regions of the antigen receptor will vary between lymphocytes. The amino acids determine its specificity.

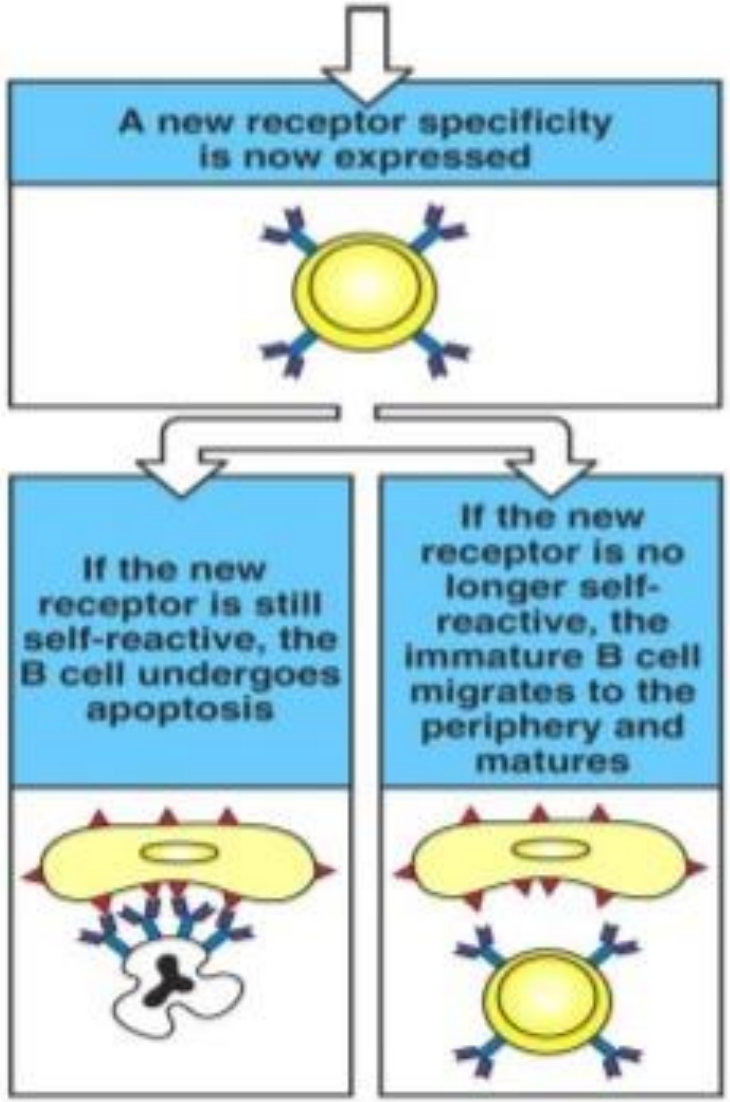
The gene segments undergo random rearrangements which increase diversity.



1) Lymph. Diversity
2) **Removal of Self-reactive Lymph**.
3) Clonal Selection of Lymph.

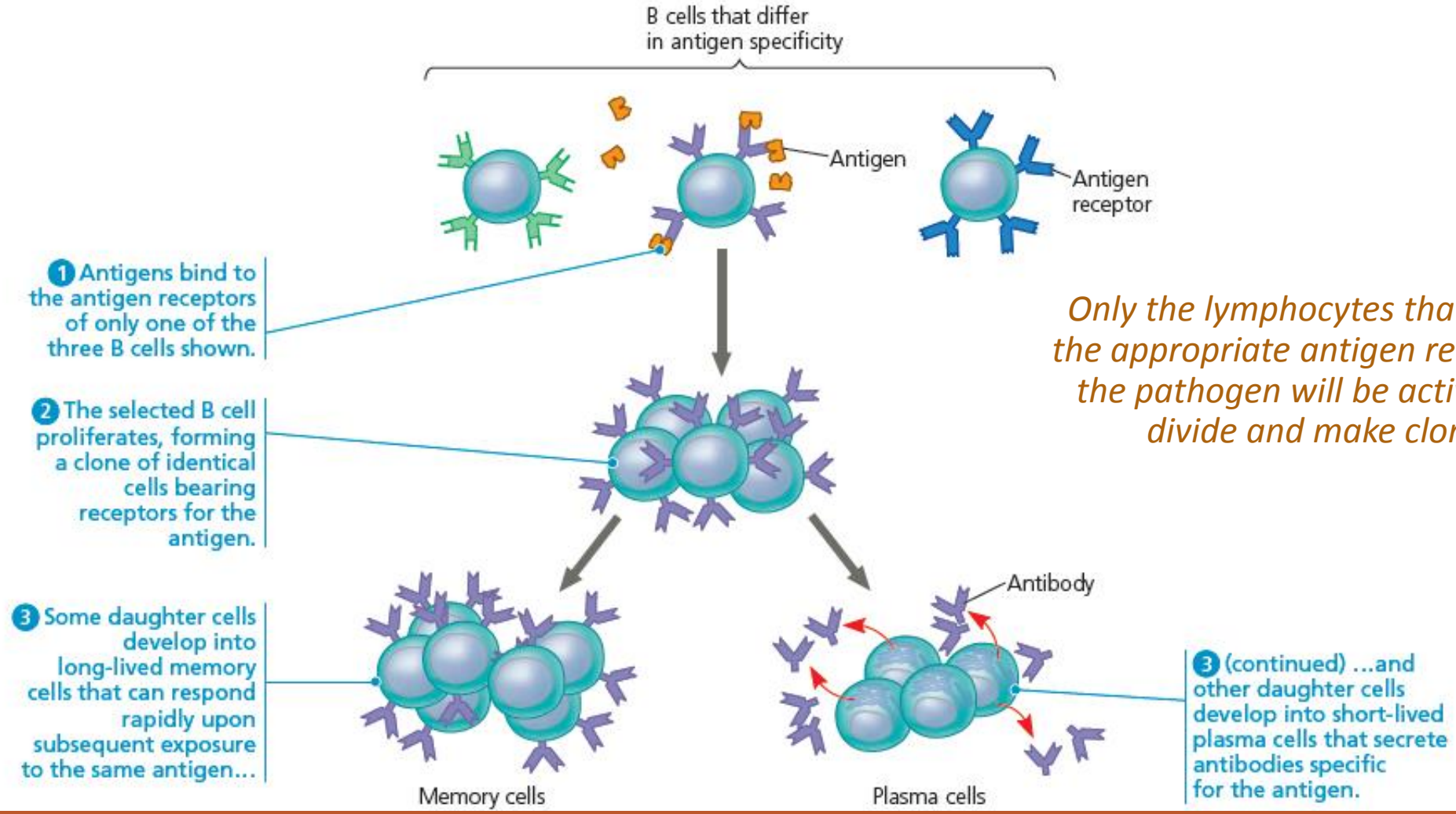
2) Removal of Self-Reactive Lymphocytes

Due to the random rearrangements, some lymphocytes may recognize antigens on the cell surface of host cells. Thus, they are tested in their site of maturation for potential of any self-reactivity.



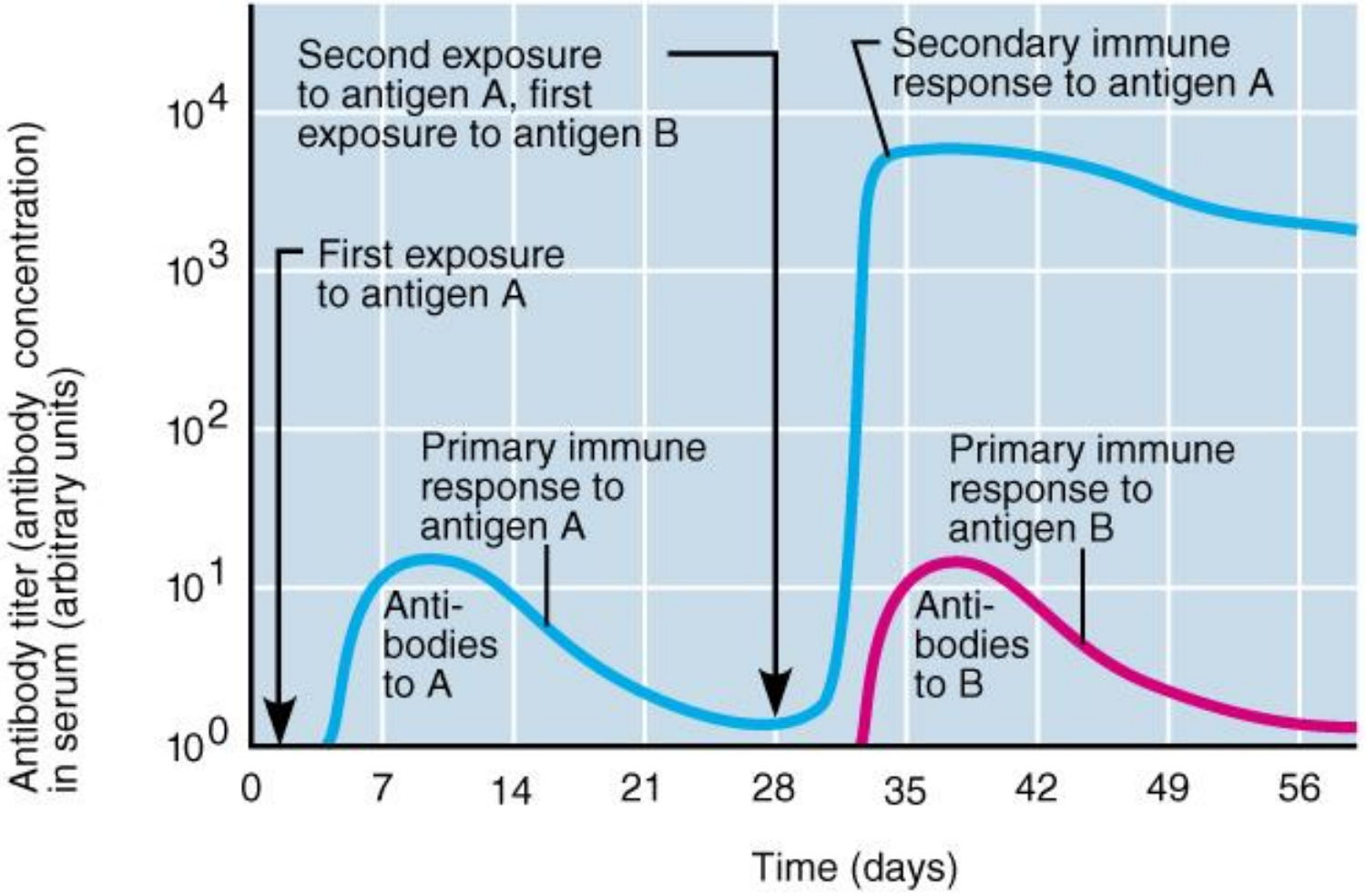
1) Lymph. Diversity
2) Removal of Self-reactive Lymph.
3) **Clonal Selection of Lymph.**

3) Clonal Selection of Lymphocytes



Only the lymphocytes that contain the appropriate antigen receptor for the pathogen will be activated to divide and make clones.

Primary vs. Secondary Immune Response

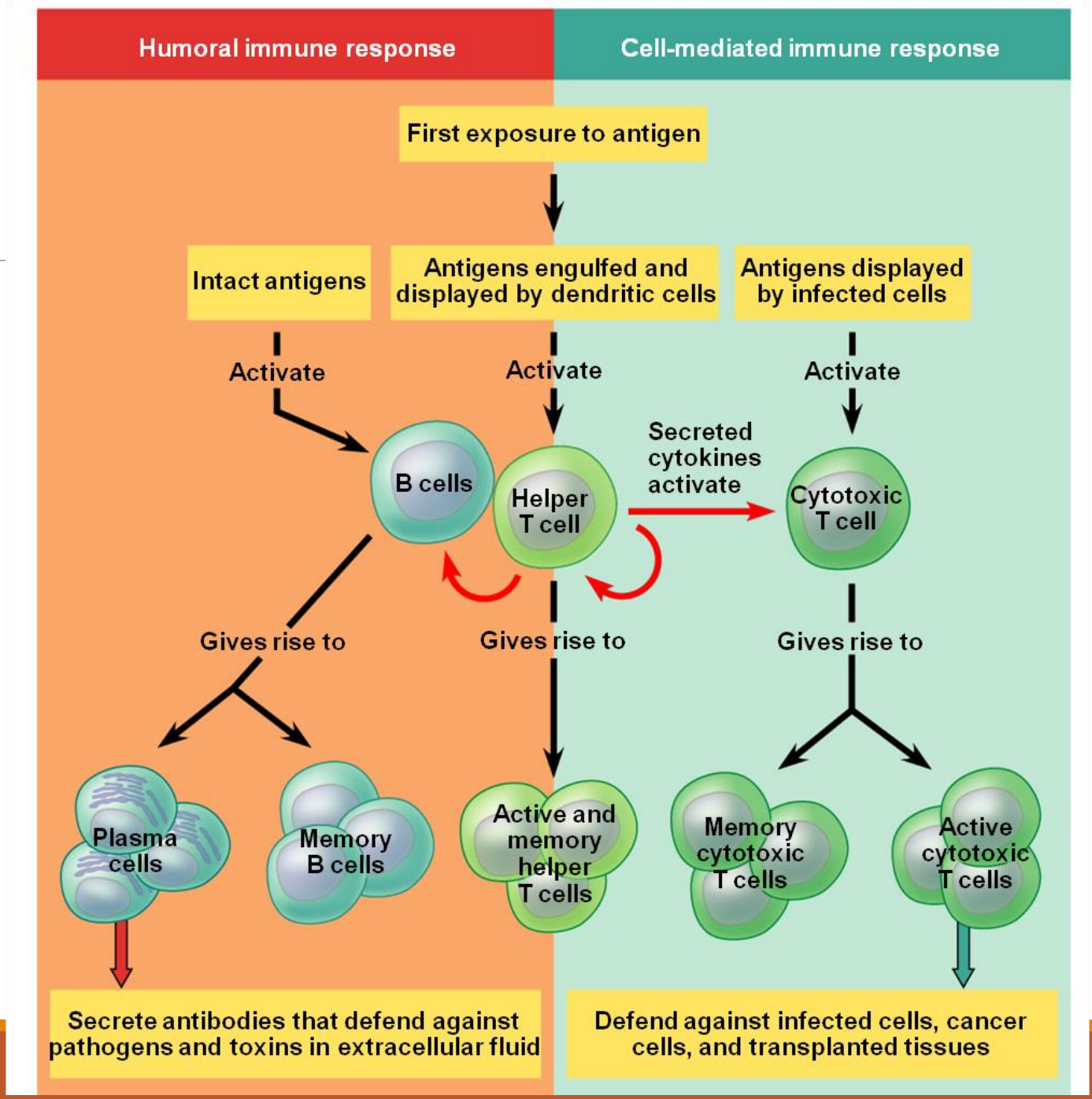


Humoral and Cell Mediated Immunity

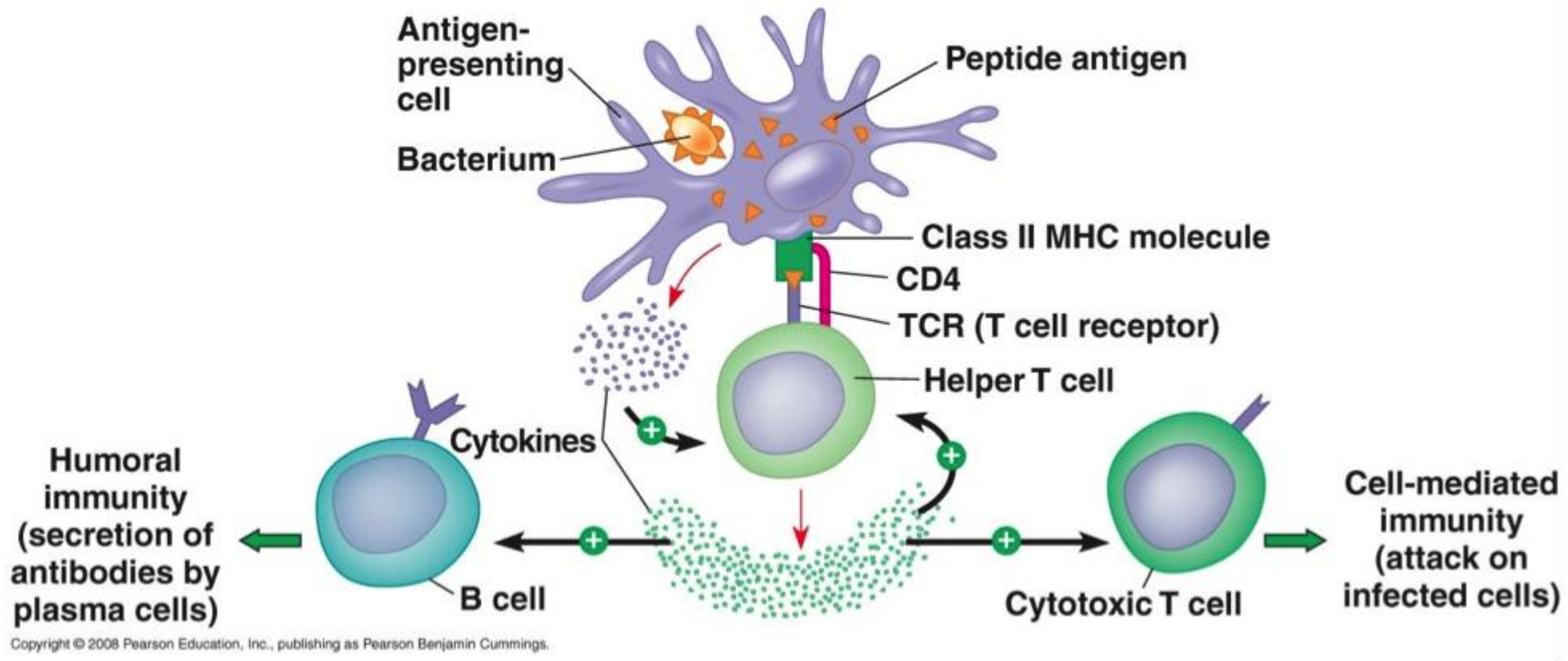
Acquire immunity can be subdivided into two branches:

1) **Humoral Immunity:**

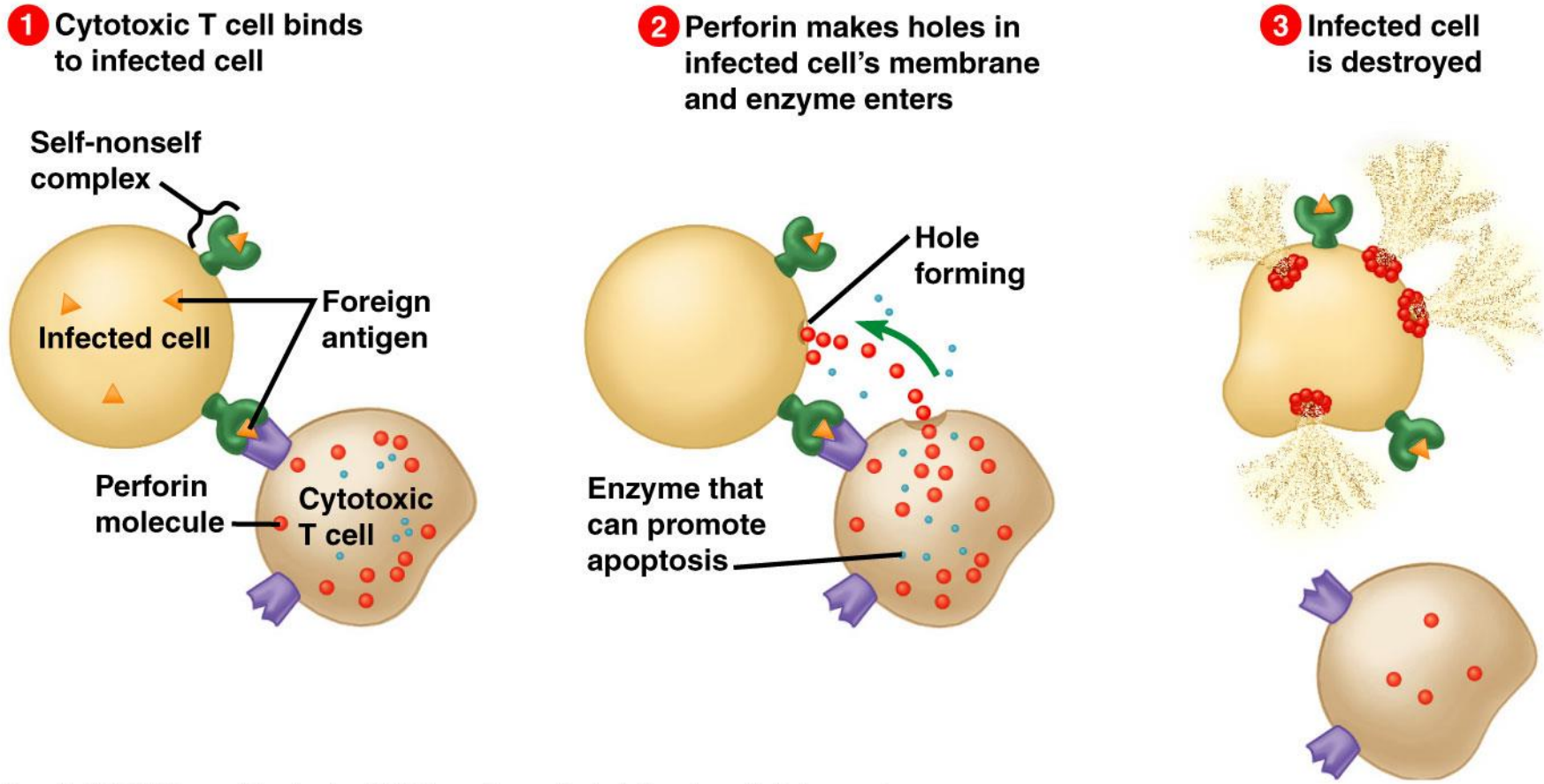
2) **Mediated Immunity:**



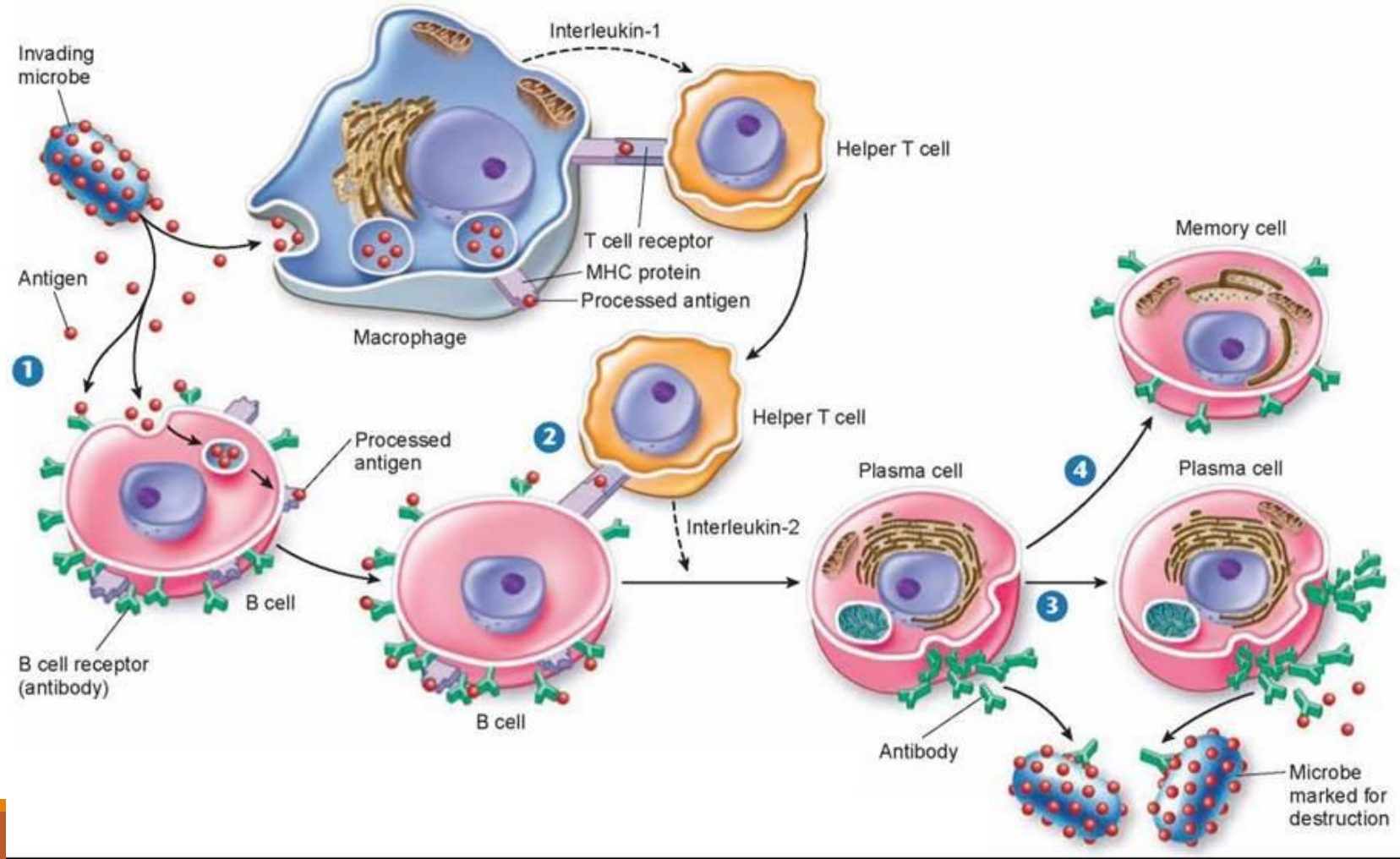
Helper T cells



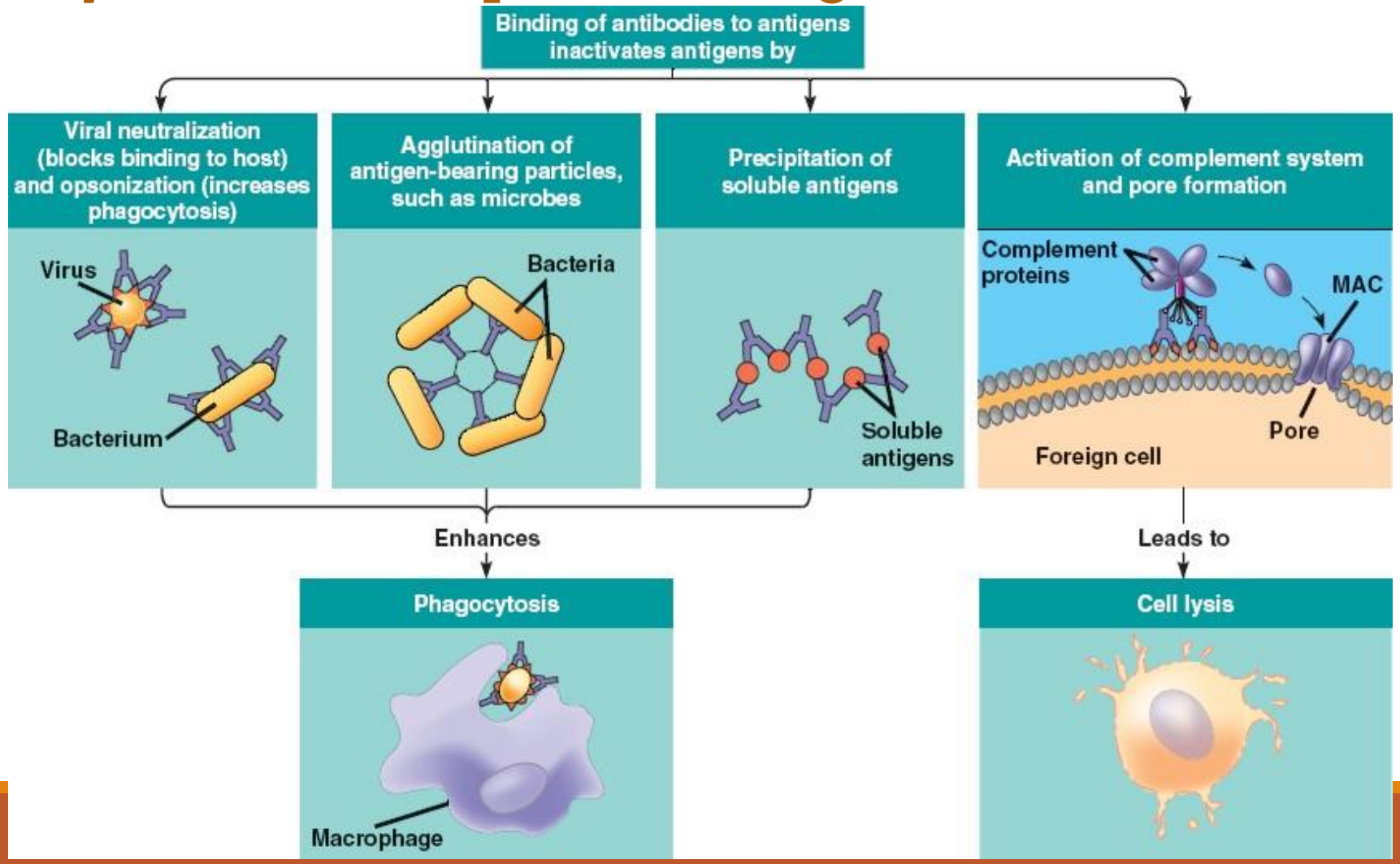
Cytotoxic T cells (Cell Mediated Response)



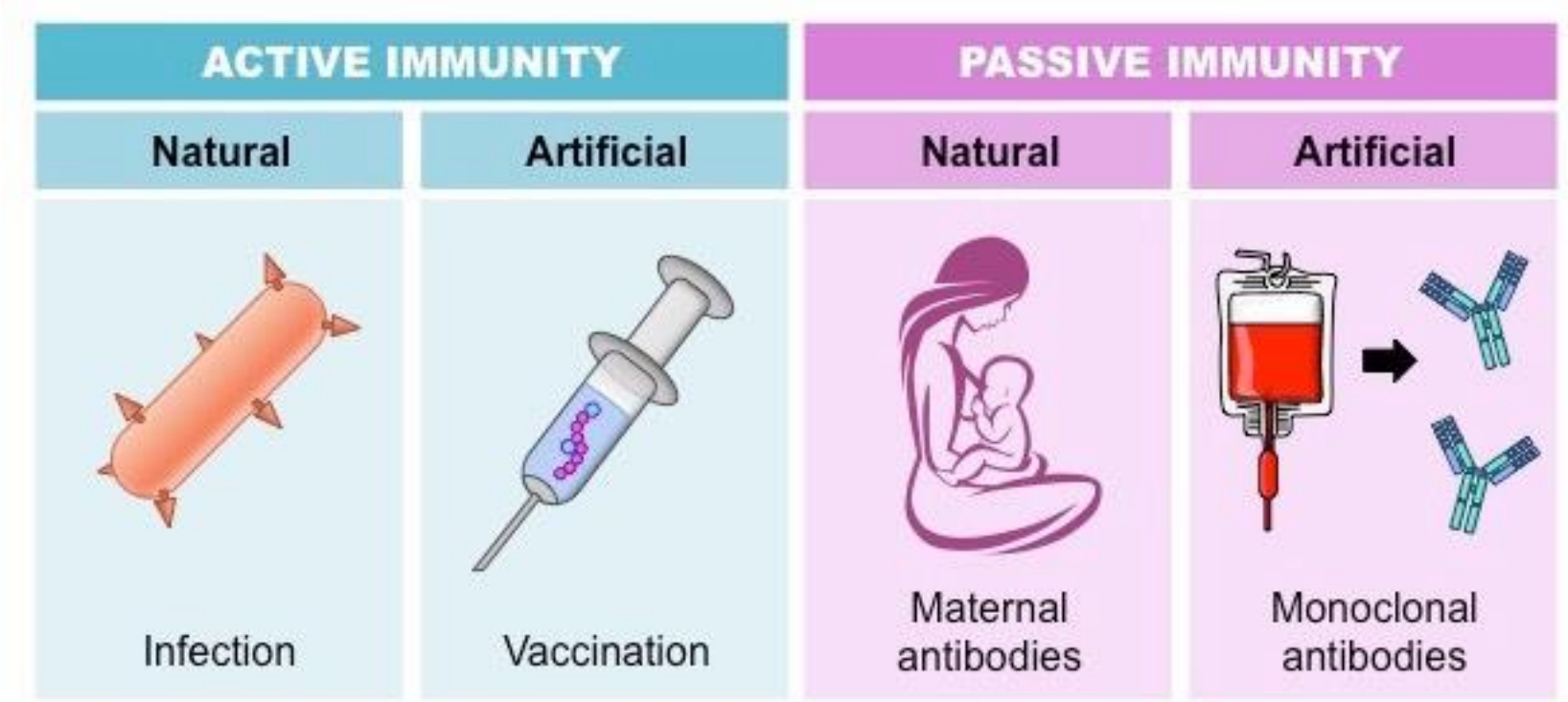
B cells (Humoral Response)

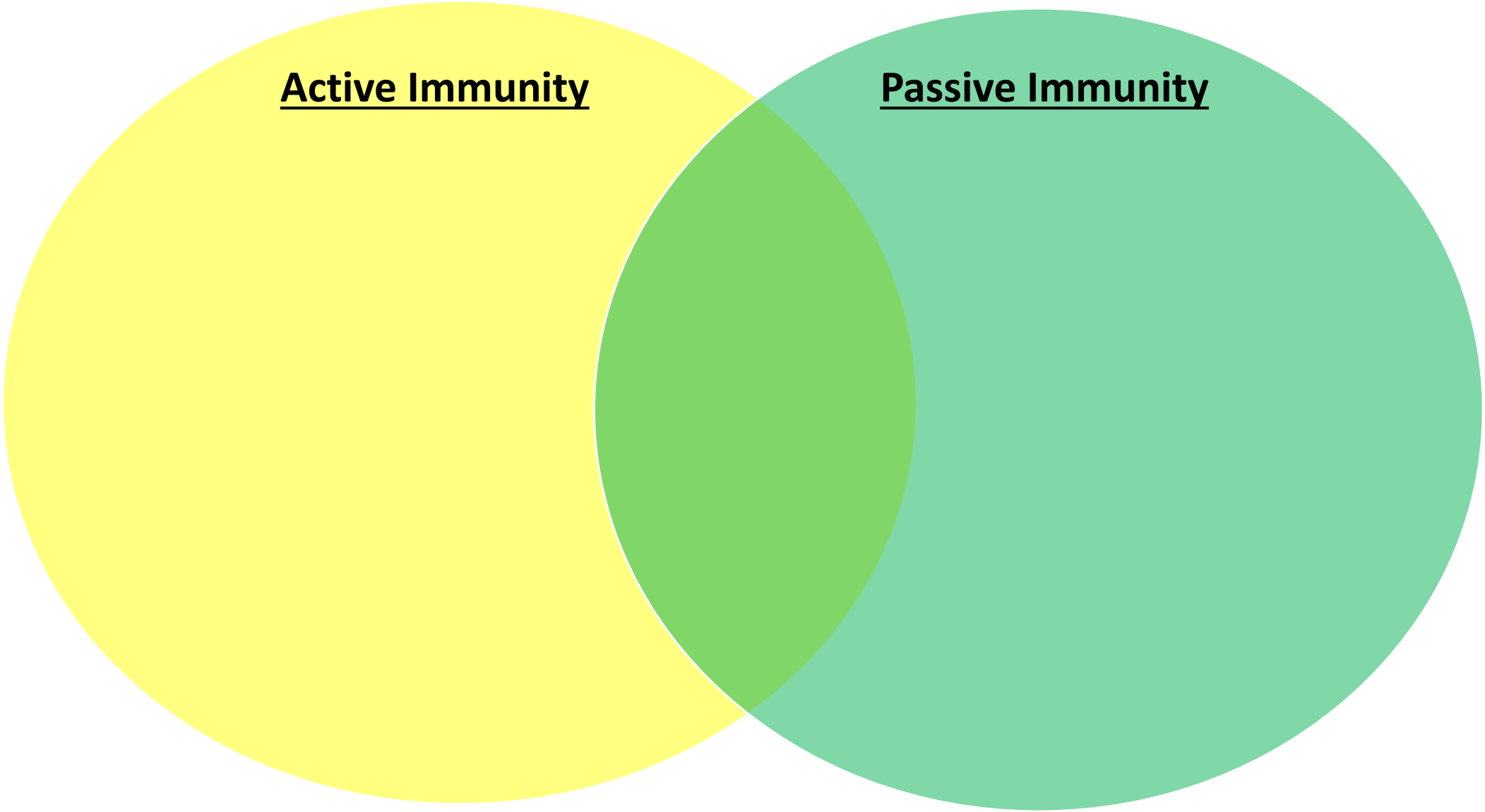


Antibody Mediated Disposal of Antigens



Active vs. Passive Immunity




Active Immunity
Passive Immunity